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ABSTRACT

Indices of motivation and demand developed to forecast postsecondary enrollment in Manitoba, Canada, are described. The indices were tested with surveys of more than 14,000 high school students with respect to actual outcomes and validated by surveying more than 5,000 students. The theoretical basis of the indices, their use in enrollment forecasting, and the accuracy of the enrollment demand prediction model are discussed. It is concluded that the use of the motivational index is to provide an aggregate measure of the motivation of students toward postsecondary education. An aggregate measure of postsecondary demand may also be developed for the demand index. This measure is composed of both student motivation and its background influencing variables such as parents' income and father's education. This index can be used to give a measure of the total demand for postsecondary education and the probability of attending postsecondary education. (SW)

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THE FORECASTING OF POST-SECONDARY DEMAND IN MANITOBA:

THE MOTIVATIONAL INDEX AND DEMAND INDEX AS

AN ENROLLMENT FORECASTING TOOL

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Mary Corcoran
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The Forecasting of Post-Secondary Demand in Manitoba: The Motivational Index and the Demand Index as an Enrollment Forecasting Tool

Abstract

The "motivational index" and the "demand index" were developed to forecast the motivations and intentions of high school students towards post-secondary education. These indices were tested with surveys of more than 14,000 high school students with respect to actual outcomes and validated by surveying more than 5,000 students (as to their post-high school plans). The theoretical basis of these indices, their use in enrollment forecasting and the accuracy of the enrollment demand prediction model is discussed in this paper.

1. Background to the Study

Participation rates in provincial post-secondary education declined in the early part of the seventies affecting enrollment, financial planning and capital expenditures at post-secondary institutions throughout the province. A more detailed understanding of the characteristics, intentions, plans and aspirations of grade 12 students in Manitoba was essential in order to deal with this problem. Existing enrollment forecasting methods, based mainly on a historical perspective, had proven inadequate and consequently, it was deemed desirable as well as necessary to explore alternative approaches to post-secondary enrollment forecasting.

In 1971, the Universities Grants Commission, the Department of Colleges and Universities Affairs and the Department of Education, began to assess alternative approaches for use in forecasting post-secondary enrollments. This assessment resulted in the formation of the Post-Secondary Research Reference Committee (PSRRC) which was a co-operative research committee composed of representatives of the province's universities, community colleges and various government agencies with an interest in post-secondary education. The Committee's efforts resulted in the development of a new forecasting model, Post-Secondary Demand and Enrollment Model-I (PDEM-I). The PDEM-I model was directed at the student's decision-making process and sought to profile and model the cross-pressures and impacts leading up to the final post-secondary decision outcome.

The PDEM-I studies spanned the three years, 1971-72 to 1973-74 and involved on-site surveys and interviews with grade 12 students focussing on their personal and life-context characteristics, aspirations, plans and motivations for post-secondary education. The specific purposes of these studies were to: (1) define the characteristics profile related to the post-secondary education aspirations and plans of Manitoba grade 12 students; (2) develop a system for forecasting the provincial demand for post-secondary education based on the findings of the characteristics profile and to forecast enrollments by institution, faculty and program of study for all post-secondary education institutions in Manitoba; and (3) to actually forecast and validate enrollments for the 1972-73, 1973-74 and 1974-75 academic years.

The research and development phase of PDEM-I produced a series of highly accurate forecasts with a one-year time frame. However, there was a number of limitations to the PDEM-I model. First, it was a short range model; it did not provide a long-enough lead time for universities and community colleges to react to enrollment forecast. Surveys of the high school students were undertaken in October and enrollment forecasts for the following September were presented in January. Second, the PDEM-I assessed plans and aspirations of only grade 12 students, many of whom had closed planning options in grades 10 and 11. Third, there was a desire for a more comprehensive modeling process to support a broader array of policy simulations, and fourth, there was a desire to move the PDEM project from a research-based setting in a university to an operational status in a government department.

In 1975, a second generation enrollment forecasting model, PDEM-II was introduced. This second phase reflected a movement of the model from a university research-based effort to an in-house (government department) operational status; as well, there was a movement from a short range (one year) forecast to a medium range (three year) forecast achieved by surveying grade 10 and 11 students as well as grade 12 students; the modelling process was also developed to allow for the simulation of policy decision variables and the assessment of their probable impact on post-secondary education.

Between 1971 and 1977 approximately 14,000 grade 12 students had participated in these yearly surveys. A considerable wealth of information has been developed on Manitoba's high school students - students' career plans, specific post-secondary education plans, barriers (real or potential) to their participation in post-secondary education, influencing factors on students' plans, and the impact of and level of service required for financial aid and guidance services.

In 1978-79 a research project was undertaken to validate the post-secondary demand and enrollment model. Approximately 5,000 students who had been surveyed in grade 12 during the period 1971-72 to 1977-78 were followed up, with the objective of validating student intentions regarding post-secondary attendance with actual outcomes.

The following discussion of the "motivational index" and the "demand index" is based on this follow-up survey. A description of the factors composing each value, is given, as well as the indexes used in forecasting enrollments, and a comparison of the "motivational index" for those students who actually went to post-secondary education with those students who did not go on.

2. The "Motivational Index"

The "motivational index" was developed and based on the results of five years of empirical research, and it was gradually changed and modified over that time period. Its development was based on the student responses to three main groups of questions on high school surveys which concerned the motivations of these students towards post-secondary education. These three main groupings included questions on (a) the influence of individuals, (b) the influence of circumstances and, (c) the influence of high school activities in planning for post-secondary education.

The survey questions looked at 25 specific factors which may influence students' plans for the future (persons, high school activities and circumstances). Students were asked to indicate the degree of influence of these various factors on their plans on a scale from 1 to 7. Those variables having a statistically significant influence on the "going" and "not going" post-secondary decisions of students were monitered and lead to the development of an index of motivation.

As one would expect, there were some differences in the levels of significance of certain impacting variables from year to year and in their relative influence on the "going" and "not going" post-secondary student decisions. However, the consistency of response of students to the influence of many of the factors provided the opportunity to develop a more general indicator of high school students motivation to post-secondary education.

The concept of a "motivational index" was developed to represent the responses by students to statistically significant influencing factors in the "going post-secondary" and "not going post-secondary" decision groups. The "motivational index" was defined mathematically as:

$$M_j = \sum_{i=1}^{K} G_{ij} - \sum_{i=R+1}^{n} D_{ij} \qquad (1)$$

where for all G_{ij}, $P_{ic} > P_{id}$ and $P_{ic} - P_{id}$ is significant at the selected level of confidence (mostly .05) and for all D_{ij}, $P_{id} > P_{ic}$ and $P_{id} - P_{ic}$ is significant at the (mostly .05) level of significance.

We have:

P_{ic} = proportion of students in the going groups who said that variable i had a major influence on their decision

P_{id} = proportion of students in the not going group who said that variable i had a major influence on their decision making

G_{ij} = a scale value which was selected by the j^{th} student for the i^{th} variable and indicates the level of influence of a factor on their decision making

D_{ij} = a scale value selected by the j^{th} student for the i^{th} variable and indicates the influence of this variable on the decision

k = total number of significant variables influencing the going decision group

n = total number of variables which influence the going and not going groups

M_j = value of the "motivational index" for the j^{th} student

Table 1 indicates the 17 factors which were used in the computation of the "motivational index" and the direction of their influence on the "going post-secondary" group. Those variables which were found to have a statistically significant positive influence on those students who indicated that they wished to go on to post-secondary education were added to the "motivational index" while those variables

which had a statistically significant influence on the "not going post-secondary" decision group were subtracted.

The actual level of significance of influence on the "going" and "not going" post-secondary student decisions is also indicated in Table 1. The only major differences between what the students indicated as significant influences when in school were the factors "present state of employment and unemployment in the economy", "athletic or recreational program" and "new life style".

When the "motivational index" was tested against those who actually went to post-secondary education, there was a statistically significant difference between the "going" and "not going" post-secondary groups (Table 2).

The motivational index was developed as a simple tool to measure the motivations of potential post-secondary education attendees as simple survey questions about possible future post-secondary plans do not necessarily distinguish between those who might or might not attend. Questions on the high school demand surveys also asked students to categorize their post-secondary decision (Table 3). The results show that while those who are certain they would attend post-secondary usually do go on, large percentages of students who were either undecided, or definitely not going on to post-secondary education eventually did go on. The "motivational index" provided one method to assist in better understanding the motivations and desires of students to attend post-secondary education. However, to develop measures of their actual demand for post-secondary education, other measures were necessary. This lead to the development of the "demand index".

3. The "Demand Index"

The "Demand Index" was developed to provide a measure of the actual probability of a student entering post-secondary education. The probability of entering post-secondary education after high school can be expressed in terms of conditional probabilities. The probability of entering is dependent on certain personal, life-context and motivational characteristics such as their motivation towards post-secondary education, their academic performance, father's level of education, family income, student statements regarding plans regarding going to university, student statements regarding going to community college, and other non-post-secondary educational plans the students may have in mind.

Logit analysis is used to determine the relationship between these variables and the going post-secondary decision. A logit equation states the odds for going on to post-secondary education education as a log-linear function of the explanatory variables for the post-secondary decision.

We may define the odds in favour of post-secondary attendance by $\frac{P_n}{1 - P_n}$

where p is the probability of entering the post-secondary institution, the logit equation states that:

$$\text{Log}_e \frac{P_n}{1-P_n} = B_o + \sum_{i=1}^{k} B_i \text{Log}_e X_{in} \qquad (2)$$

where p_n is the probability of the n^{th} student continuing their education next year given that they had a value for their motivational index of X_{1n} fathers's education of X_{2n} etc.

We may solve our equation for P_n and the left side odds of going post-secondary gives:

$$P_n = \frac{1}{1+e^{-B_o \pi_i X_{in}^{-B_i}}} \qquad (3)$$

i= 1.2. ..... k and X_{in} only takes positive values.

Now, to forecast the probability of a student attending post-secondary education (their demand for post-secondary education) we first must estimate the relationships between the significant explanatory variables and the conditional probability for entering post-secondary education, and then forecast the "going" and "not going" decisions based on the estimated probability of attending.

The "demand index " may be used to simplify the relationships involved. We can create it by summing the values of the significant influencing variables into an index form, "motivational index", father's education, family income, student statements regarding their going to university plans, student statement regarding their going post-secondary plans, "other" plans a student may have and academic standing.

TABLE 1

MOTIVATIONAL INDEX VARIABLES[1]

VARIABLE	SIGN USED IN COMPUTATION	VALIDATION OF INDEX VARIABLES
A. INFLUENCE OF INDIVIDUALS		
Friends	Negative	- 2.13 (*)
Relatives (other than parents)	Positive	1.85
Employers	Negative	- 3.09 (**)
B. INFLUENCE OF HIGH SCHOOL ACTIVITIES		
Participation in activities having a future usefulness	Positive	1.96 (*)
Prepared with skills for immediate employment	Negative	-10.53 (***)
Well prepared for continuing education	Positive	16.50 (***)
Personal contact with representatives of institutions of higher education	Positive	4.96 (***)
Someone assisted me in finding employment after high school	Negative	- 6.96 (***)
Information received about opportunities for continuing training and education	Positive	6.19 (***)
C. INFLUENCE OF CIRCUMSTANCES		
Present state of employment/unemployment in the economy	Positive	- 0.91
Knowledge of areas of good employment opportunity	Positive	1.34
Athletic or recreational program	Positive	- 1.99 (*)
Social life	Negative	- 1.74
New life style	Negative	- 0.07
Opportunity to live away from home	Negative	- 4.15 (***)
Reputation of institution or organization I have chosen	Positive	9.52 (***)
Religious relationship	Positive	1.09

1. 1976 and 1977 survey variables used in PDEM-II model

*** < .001

** < .01

* < .05

TABLE 2

VALIDATION[1] OF GOING VERSUS NOT GOING GROUPS

FOR MOTIVATION AND DEMAND INDEX

INDEX	SIGNIFICANCE
Motivation Index	21.04 ***
Demand Index	15.71 ***

*** p .001

1. 1976 and 1977 Survey Years

TABLE 3

PARTICIPATION IN POST-SECONDARY EDUCATION

BY GRADE 12 DECISION GROUP

N=2819

Grade 12 Decision Group	Participation in Post-Secondary	
	Yes	No
Going University (N=614)	94%	6%
Going Community College (N=224)	74%	26%
Going Impacted (N=458)	71%	29%
Going Other (N=261)	88%	15%
Undecided (N=232)	47%	53%
Not Going (N=183)	40%	60%
Other Plans (N=73)	41%	59%

Note: Grade 12 Decision Group is based on students' responses to high school surveys regarding future post-secondary plans.

Participation in Post-Secondary is based on actual outcomes with respect to intentions.

We may represent the probability (P_n) on the left hand side of equation (2) by the observed relative cumulative frequency of the "demand index" values of those students wishing to continue their education. The probabilities are dependent on the values of the explanatory variables and it is assumed that a log-linear relationship exists between the explanatory variables and the probabilities of equation (2).

The relationship is then estimated using least squares. Once B_o and B_i are known from our regression equation, then we use equation (3) to forecast the actual probability of a student's attending post-secondary education using the corresponding values of explanatory variables as predictors.

The log-linear relationships are estimated by stepwise multiple regression and can be expressed by equation (4). This equation explained over 90% of the variance in the odds for going to post-secondary education. This yields:

$$\text{Ln}\frac{P_{n77}}{1-P_{n77}} = -37.999 + 8.973 \text{ Ln } X_{ij} + 0.579 \text{ Ln } X_{2j} - 1.00 \text{ Ln } X_{3j} + 0.482 \text{ Ln } X_{4j} + 0.296 \text{ Ln } X_{5j} + 0.714 \text{ Ln} X_{6j} + 0.419 \text{ Ln } X_{7j} \quad (4)$$

where the variables are:

X_1 = motivational index
X_2 = income of parents
X_3 = other plans
X_4 = fathers education
X_5 = going to university
X_6 = academic average
X_7 = plans regarding post-secondary education

for the j^{th} student

The results from the regressions are used to estimate the probability distribution of students going to post-secondary education. The probability of entering post-secondary education is estimated by substituting student's independent variables in an equation and calculating the value of the dependent variable P_n (Probability of going). For example:

$$P_{n77} = \frac{1}{1+e^{37.999 \cdot X_{1n} \cdot X_{2n} \cdot X_{3n} \cdot X_{4n} \cdot X_{5n} \cdot X_{6n} \cdot X_{7n}}} \quad (5)$$

where n is nth student in the sample.

TABLE 4

DEMAND INDEX VARIABLES[1]

Variable	Sign Used In Computation of Index	Significance
Motivation Index	Positive	15.71 (***)
"Other" Plans	Negative	-11.43 (***)
Income	Positive	4.27 (***)
Father's Education	Positive	9.74 (***)
Plans - Go University	Positive	19.07 (***)
Plans - Go Community College	Positive	-2.09 (*)
Academic performance	Positive	12.13 (***)
Certainty of financing	Positive	15.09 (***)

1. 1976 and 1977 survey variables

* .05
** .01
*** .001

After calculating a P_n value for each student, we multiply this probability by the total student frequency distribution to estimate the weighted percent of going post-secondary students. This gives us the total sequential student demand weight:

$$D_t = \sum P_{ni} \cdot f_D \qquad (6)$$

where P_{ni} is the cumulative probability for going on to post-secondary education at demand index value of i while f is the observed frequency in the total sample at i. D is the number of students in the sample wishing to go on to post-secondary education .

We calculate the participation rate at post-secondary education using the relation:

$$PR = \frac{D}{N} \qquad (7)$$

where PR is participation rate D is total sequential demand and N the sample size.

The actual number of students is then estimated by the relationship:

$$TSD = PR \cdot E \qquad (8)$$

where PR is the participation rate and E the grade 12 enrollment, TSD is the total sequential demand.

4. CONCLUSIONS AND RESULTS

The major value in the use of the "motivational index" in analyzing the plans of students regarding post-secondary education is to provide an aggregate measure of the motivation of students towards post-secondary education. In validating the index, the major benefit occurs in becoming more aware of the actual influence of various variables in motivating students. By becoming more aware of the variables and the magnitude of their influence, better information is available for career counselling and counsellors can be better able to understand where to direct their counselling efforts.

Also, an aggregate measure of post-secondary demand may be developed from the "demand index". This measure is composed of both student motivation and their background influencing variables such as parents income, father's education etc. This index can be used to give a measure of the total demand for post-secondary education and the probability of attending post-secondary education. The relationship of variables within the "demand index" give further insights for educators into the variables which influence student decision making. With this information, more effective counselling is possible.

The majority of the "motivational index"variables (see Table 2) had both their level and direction of influence remain significant in influence on future plans as when measured in high school. The real advantage in validating the "motivational index" is in obtaining an improved insight into the influencing variables and their true magnitude and direction of influence and in trying to explain and account for any changes in influence.

"Demand index variables", when validated, had a highly significant relationship with the actual outcomes of students. These variables are the major influencing factors in a student's decision to attend further education. By measuring these, one is able to obtain a picture of the student's actual probability of post-secondary education attendance.

Table 5 compares the PDEM model predictions with actual enrollments for the years 1976 to 1978. In all years, except 1978, the forecasts were within the $\pm$ 2% error.

There are two main sources of error in the enrollments forecasts. These are: (1) Administratively induced errors. The forecasts for the following September were developed the previous November. Any changes in administrative policy between the time the forecasts were made, and when students are actually admitted without incorporating these changes in the model, would result in enrollment forecast errors. Examples of such administrative changes were changing course quotas and changing definitions of full or part-time student status; and (2) Other sources of enrollment. The PDEM model predicts first time full-time sequential enrollments from the high school surveys. Second, third and fourth year enrollments, part-time and graduate enrollments

non-sequential enrollments, and international and interprovincial enrollments are produced using other projection techniques such as cohort survival.

Significant changes in the continuation rate of in-process students at one of the universities was a major source of forecast error.

TABLE 5

COMPARISON BETWEEN PDEM MODEL PROJECTIONS

AND ACTUAL FULL-TIME EQUIVALENT ENROLLMENTS

	PDEM 1976 PROJECTION	1976 ENROLLMENTS	DEVIATION (%)	PDEM 1977 PROJECTION	1977 ENROLLMENTS	DEVIATION (%)	PDEM 1978 PROJECTION	1978 ENROLLMENTS	DEVIATION (%)
University of Manitoba	15,793	15,246	3.6	15,735	15,856	(0.8)	15,752	14,757	6.7
University of Winnipeg	2,972	3,188	(6.8)	3,799	4,137	(8.2)	3,773	3,655	3.2
Brandon University	1,295	1,325	(2.3)	1,665	1,718	(3.1)	1,676	1,417	18.3
St. Boniface College	207	190	8.9	208	249	(16.5)	283	240	17.9
TOTAL	20,267	19,949	1.6	21,407	21,960	(2.5)	21,537	20,069	7.3

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